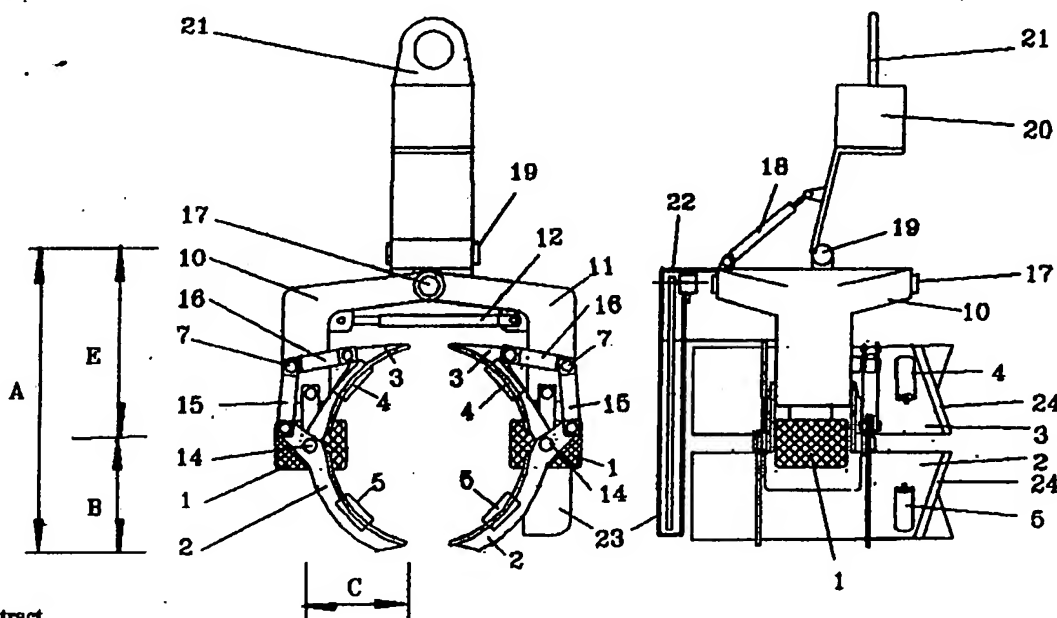




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/FI92/00027 (22) International Filing Date: 3 February 1992 (03.02.92) (30) Priority data: 910735 15 February 1991 (15.02.91) FI (71)(72) Applicant and Inventor: MOISIO, Juha [FI/FI]; SF-44670 Suovanlahti (FI). (72) Inventor; and (75) Inventor/Applicant (for US only) : MOISIO, Jouko [FI/FI]; Tuurentie 7, SF-44500 Viitasaari (FI). (74) Common Representative: MOISIO, Juha; SF-44670 Suovanlahti (FI).		(81) Designated States: AT, AT (European patent), AU, BE (European patent), BG, BR, CA, CH, CH (European patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FR (European patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KR, LU (European patent), MC (European patent), NL, NL (European patent), NO, PL, RO, RU, SE, SE (European patent), US. Published <i>With international search report.</i> <i>In English translation (filed in Finnish).</i>

(54) Title: FELLER GRAPPLE**(57) Abstract**

A cutting, delimbing and trimming grapple for a multifunction tree harvester, characterised by that the feed rollers (1) or alternatively the drive wheels which propel the trunk against the delimbing cutters are located on support arms (10 and 11) operated by hydraulic actuators or similar devices. The delimbing cutters are placed to present short leverage arms (dimensions C and B) and are situated close to the feed rollers, so that the forces arising from delimbing and the acceleration and deceleration of a trunk are not directed against the pin (17) joining the support arms (10 and 11), and do not bear with the leverage arms (A and E) resulting from the dimensions of the grapple frame. Then the frame and support arms (10 and 11) may be manufactured on the basis of a lighter design.

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FELLER GRAPPLE

One of the main impediments involving felling, delimbing and cutting grapples can be traced to the operation of the delimbing cutters. The compressive force exerted by the cutter blades has usually varied with the size of the load, whereby a high pulling force exerted by the feed rollers to delimb large branches has enlarged the compressive force applied by the delimbing cutters against the trunk to be delimbed, resulting in a tendency of the cutters to choke. This has made it difficult to process the trunk flexibly.

Concomitantly, the power required by the feller grapple increases considerably, demanding greater power requirements and more weight at the grapple hydraulic motors and higher strength and weight of the grapple itself.

The location of the feller grapple at the end of a long hydraulically actuated boom causes the weight of the grapple to decisively affect the operation of a multi-function tree harvester.

The thinning of a forest demands a high level of operating speed per felled tree from a tree harvester. The ability to process several trees from a single location becomes decisive under these conditions.

The characteristics of the invention are described in the claims.

Illustration 1 presents a simplified diagrammatic representation of the structural aspects of our invention, illustration 2 shows for purposes of structural comparison a diagrammatic representation of a structure typified by US Patent 3542 099, and illustration 3 shows a structural diagrammatic representation of a common design.

Illustration 4 shows an application of the invention, depicted both perpendicularly and parallel to the direction of travel of a tree being processed.

When the grapple and the trunks being processed hang freely, then the loads arising from lifting and carrying the trunks are modest relative to the loads created by delimbing and the acceleration and deceleration of a trunk. If the grapple is dimensioned mainly to resist the loads created by delimbing, it will obviously with the addition of a small factor of safety also resist other loads which may give rise to load peaks.

Due to the criticalness of weight, the unpredictability of the loads and the complexity of the structure, the final definition of the structural strength of the grapple is best determined through trial runs.

This description seeks to strongly simplify the loading cases in order to set apart the characteristics mentioned in this patent application.

In the structure depicted in illustration 3, the feed roller 5 creates a couple M_3 around an arm L_3 at point 6. This couple stresses the frame 1. When the delimbing cutter 3 collides against a branch or whittles the trunk, large shock loadings such as the loads F_1 and F_2 are created, which acting around the arms L_1 and L_2 bring about the couples M_1 and M_2 at point 2. These couples also act against the frame 1.

The mass of the trunk 4 and the mass of the frame move in opposite directions, which greatly increases collision energies, particularly when long delimbing couple arms are involved.

Long couple arms demand a stiff design of the frame, thereby increasing its weight, which in turn require strong support arms against the forces F_1 , F_2 and F_3 , further increasing the weight of the frame.

The results of the couples against the frame must be added, since all may obviously occur simultaneously.

A frame must essentially be dimensioned for stiffness, whereby a small increase in torque will have a significant effect on weight.

In the design represented by illustration 2 the trunk must be pressed during delimbing against the feed roller 5 at the upper part of the grapple. The delimbing cutters must carry

the trunk and press it upwards in addition to the pressure required by delimbing. Structurally this design is inferior to the solution presented in illustration 3.

5 Illustration 1 presents a similarly simplified calculation model of the delimbing cutter forming the subject of this application. In this design the trunk travels through an arched structure hinged at its center. The same arched arms hold the feed rollers and their motors as well as the
10 delimbing cutters. The design does not have a frame as such, as it has been replaced by a hinge pin, and thus the lack of a frame prevents the creation of inertia forces during deceleration or acceleration of the trunk and delimbing. The design of the arms and the location of its accessories, such
15 as the hydraulic motors driving the feed rollers bring the center of gravity 9 of the arms close, L3, to the mounting points 8 of the delimbing cutters, which are located near the feed rollers. All forces F, F1 and F2 are near each other, and therefore high couples cannot be produced since
20 the leverage arms remain short. The leverage arms L1 and L2 of the delimbing cutters are also minimised to the greatest extent. The couples caused by the shock F1 and F2 of several branches being cut simultaneously should not be added together, since they actually nullify each other. Delimbing
25 requires a certain speed of the trunk 1 and a reasonable mass of the grapple. In the design represented by this invention the mass of the grapple has been exploited to the maximum, while its lighter structure increases the reach and agility of the forest machine.

Illustration 4 represents one solution, where the motion of the tree has been achieved by means of hydraulically powered rubber feed rollers 1 provided with a suitable friction surface. The feed rollers 1 are mounted on two support arms 10 and 11 opened and closed by a double-acting hydraulic actuator 12. The support arms 10 and 11 also carry by means of a hinge pin 14 the lower delimbing cutters 2 and the upper delimbing cutters 3. The drive actuators 16 of the upper delimbing cutters and the drive actuators 15 of the lower delimbing cutters are mounted on the support arms 10 and 11 at the pin locations 7. The upper and lower delimbing cutters 2 and 3 are operated by the double-acting hydraulic actuators 15 and 16, whereby the upper delimbing cutter 3 drive actuator 16 presses the cutters into delimbing position.

The delimbing cutters 2 and 3 are kept at the correct delimbing distance by means of the guide rollers 4 and 5, one of which acts as a length measuring device. The support arms 10 and 11 are joined together through the hinge pin 17, thus providing flexibility to allow the delimbing cutters 2 and 3 to follow the outline of the trunk, even though the tree might be strongly tapering or might present deformations in its shape and thickness. The feller grapple is mounted on the multi-function tree harvester through a hook 21. The feller grapple is brought into felling or delimbing and cutting position by the actuator 18. The grapple is rotated by the rotating actuator 20. A hydraulic motor retracts the cutting chain saw 22 into a protective

casing whenever it is not in use.

The structure of the feller grapple depicted in the illustration allows for a multiplicity of use and an extremely low expenditure of energy during delimbing operations. The rollers 4 and 5 rotating on anti-friction bearings prevent the cutting edges 24 and 25 of the delimbing cutters 2 and 3 from cutting into the trunk, thereby substantially reducing the forces required in delimbing. The compressive force applied through the supporting arms 10 and 11 to the feed rollers 1 to move the trunk remains a separate entity acting solely on the feed rollers. The factors described above take on a particular importance during the season of bast growth; they also significantly reduce the energy required by a delimbing operation. This, in turn, widens the operating range and reduces the weight of the feller grapple. The principle of this design also significantly affects the loading characteristics of the feller grapple. The structure reduces the energy expended through shocks during delimbing. In a traditional design, the hinge 17 would have to resist delimbing shock loads acting over a leverage arm A and the acceleration forces of the trunk over a leverage arm E, while these forces could occur simultaneously and from opposite directions, and these forces would be dependent upon the masses of the trunk being processed and of the delimbing grapple and upon the magnitude of the shocks caused by delimbing, and in many cases their directions would be opposite. In this solution, the acceleration and

deceleration forces of the trunk act on the feed rollers 1, while the bearing support 14 of the delimbing cutters is located almost on the same centerline. Since during a delimbing operation the feller grapple usually hangs freely, the shock loads arising from a delimbing operation cannot greatly load the hinge 17, thereby permitting a lighter design of the parts 10 and 11 as well as of the whole grapple.

As the entire weight of the feller grapple is being held at the end of a long boom, even small reductions in weight can be successfully used to advantage either through a reduction of the gross weight of the multi-function tree harvester or through an increase in the reach of existing machinery.

This solution presents several further advantages over traditional designs in thinning cuts and under conditions where light wood must be processed. This invention makes it easy to gather trunks, previously cut or broken by storms, by pressing together the support arms 10 and 11 and opening the lower cutters to a suitable compressive position, thereby facilitating a secure grip even on difficult terrain. This invention offers two procedures to delimb and cut several trunks at the same time. The feller grapple is located on the first tree so that the lower cutters press it against the the upper cutters and the feed rollers, and the trunk is then cut. Keeping the cut trunk vertical, the feller grapple is moved to the root of the next tree, which is then similarly gripped by the lower cutters prior to

being cut. This process continues until a sufficient number of trunks have been collected, at which point the bundle is delimbed and cut to length. On the other hand, a simultaneous processing, delimbing and cutting of several trunks can be carried out by gathering them in a bundle prior to delimbing and cutting. These procedures offer important advantages, since they eliminate several work phases by the multi-function tree harvester, permitting a more efficient exploitation of thinning stands and lower costs.

This invention may be put into practice in several ways using known components. The feed rollers may be replaced with driven wheels, materials may be high strength steel either in plate form or otherwise manufactured. Many components could be justifiably built of strong aluminium or some other known material. Known technology can be applied to the feller grapple to provide motion and measurements, and the feller grapple can be mounted to the multi-function tree harvester boom using known methods.

CLAIMS

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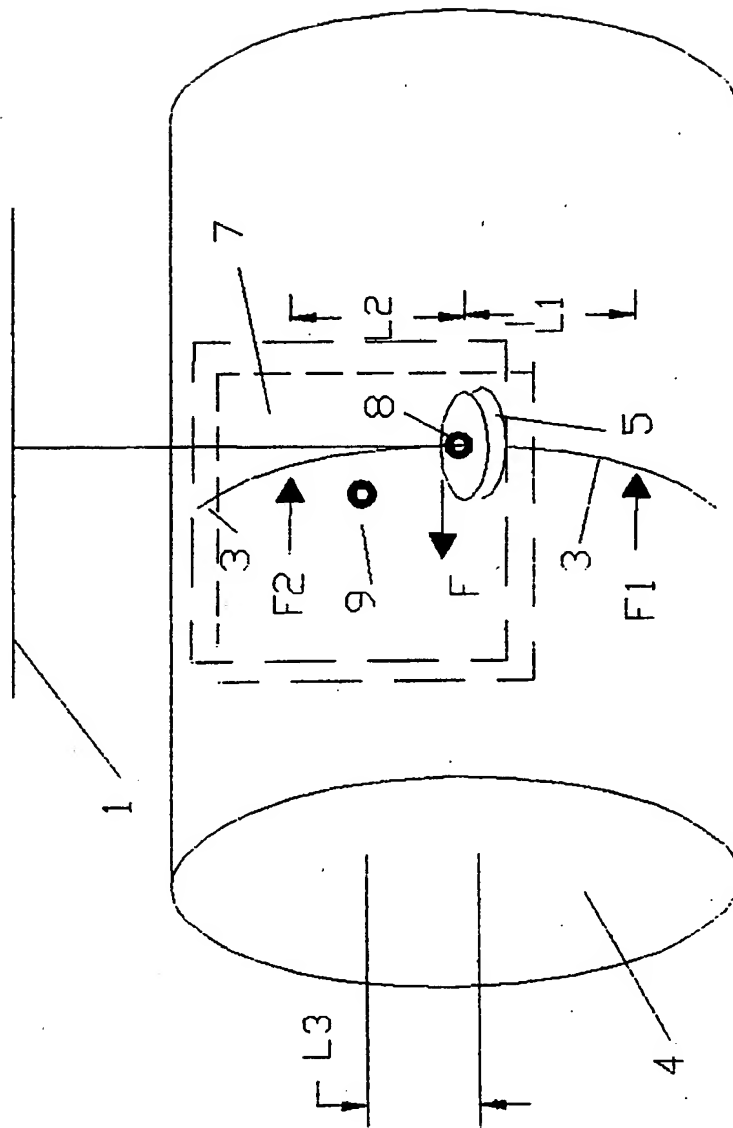
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A cutting, delimbing and trimming grapple for a multi-function tree harvester, characterised by that the feed rollers 1 (illustration 4) or alternatively the drive wheels, which propel the trunk against the delimbing cutters, are located on support arms 10 and 11 operated by hydraulic actuators or similar devices in such a position that the leverage arms are minimised (dimensions C and B) and located close to the drive rollers, thereby avoiding that the forces arising from the delimbing and the acceleration and deceleration of the trunk are directed against the support arms 10 and 11 or against the frame of the feller grapple with the leverage arms A and E, thus permitting a lighter design of the feller grapple frame and support arms 10 and 11.

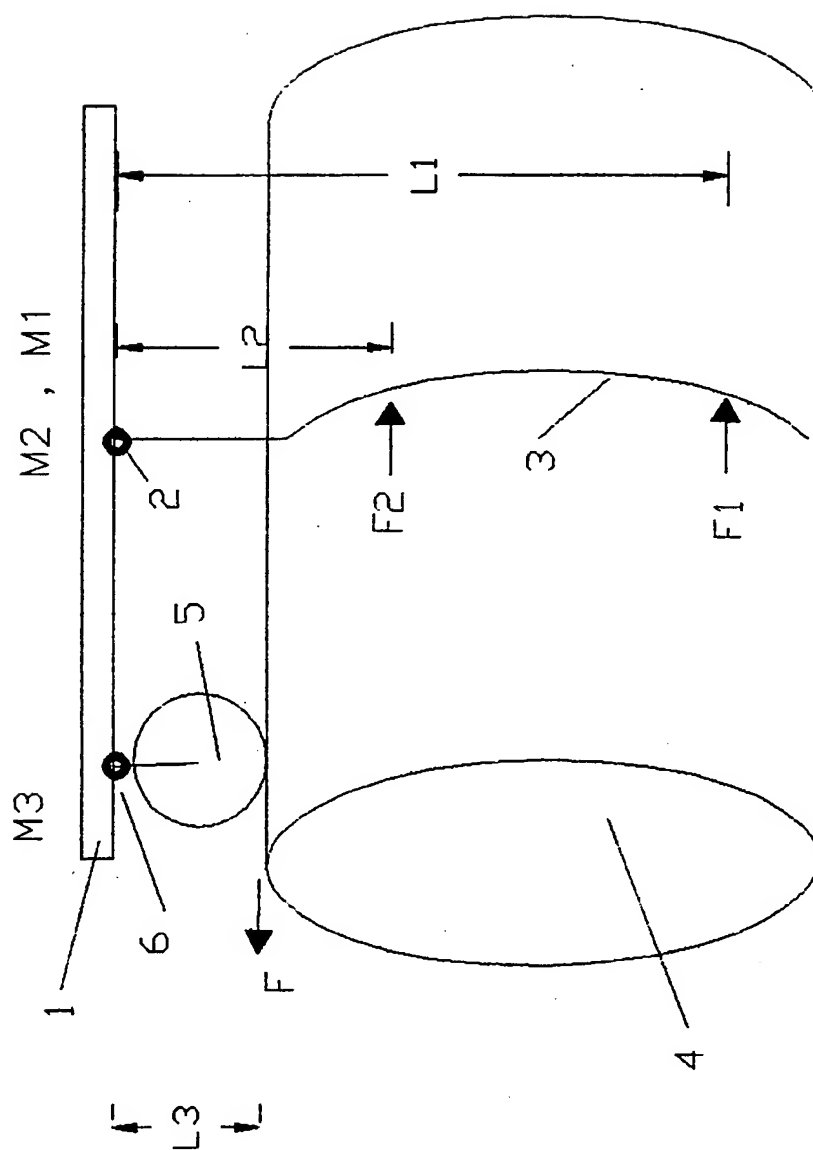
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FIG. 1



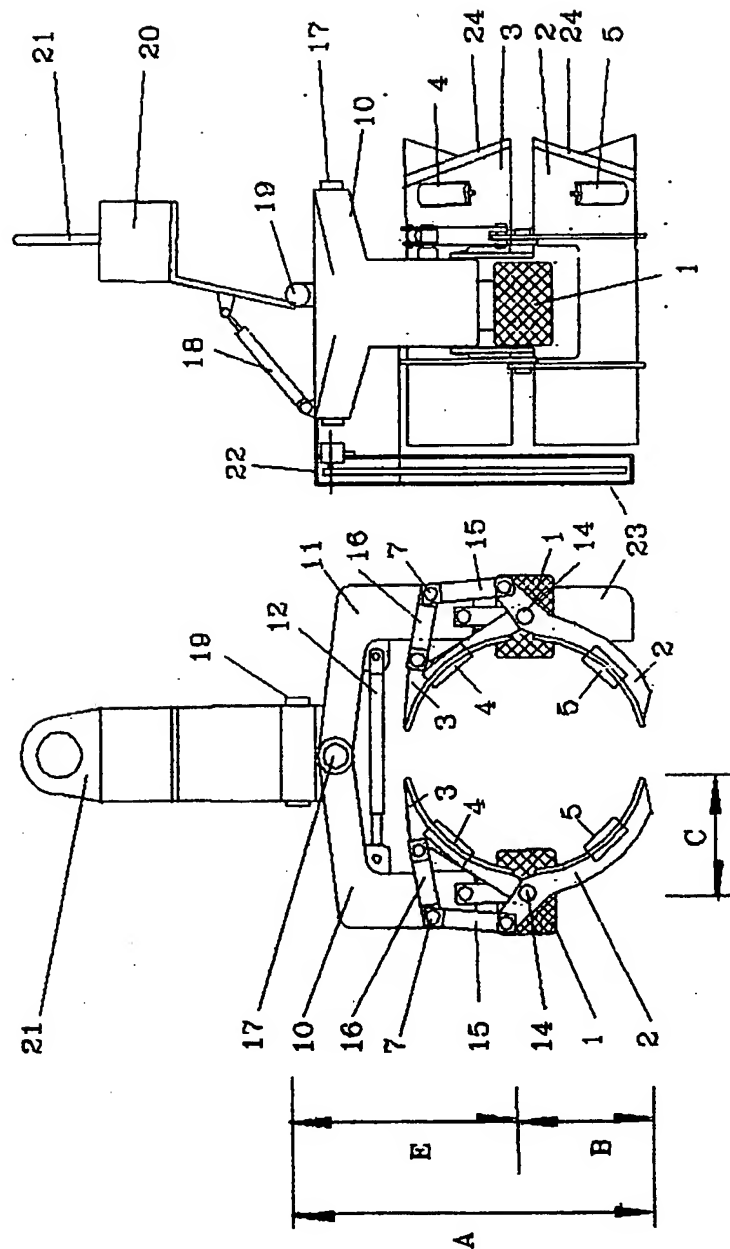
2/4

FIG. 2



4/4

FIG. 4



INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 92/00027

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC5: A 01 G 23/095		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC5	A 01 G; B 27 L	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched ⁸		
SE,DK,FI,NO classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	SE, B, 465157 (JAN ERIKSSON) 4 September 1989, see figure 1 --	1
Y	Derwent's abstract No. C67 82 C/12, SU 673 455, publ. week 8012 (FOREST POWER MECHN INST) --	1
Y	Derwent's abstract No. H66 08 B/36, SU 634 937, publ. week 7936 (FOREST POWER MECHN INST) --	1
A	US, A, 4974648 (PROPST) 4 December 1990, see figure 4 --	1
<p>* Special categories of cited documents:¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
8th May 1992	1992 -05- 20	
International Searching Authority	Signature of Authorized Officer	
SWEDISH PATENT OFFICE	Eddy Leopold	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	<p>US, A, 3542099 (DUANE M. GIBSON) 24 November 1970, see figure 12</p> <p>---</p> <p>-----</p>	1

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 92/00027**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on **28/03/92**
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SE-B- 465157	89-09-04	SE-A- 8800748	89-09-04
US-A- 4974648	90-12-04	CA-A- 2010407	90-08-27
		DE-A-C- 4005185	90-08-30
		SE-A- 9000677	90-08-28
US-A- 3542099	70-11-24	NONE	